

Prehistoric Land Use Patterns in the Guillermo River Basin (Southwestern Patagonian Forest, Argentina): A First Look at the Gis Dataset of Surface Lithic Material

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ABSTRACT

This paper presents an initial analysis of surface lithic material from the Argentinian stretch of the Guillermo River basin, located in the southwestern forest of mainland Patagonia (southernmost South America). Integrating spatial distributions of isolated artifacts, lithic clusters and archaeological sites in an archaeological GIS dataset, a Kernel Density Analysis indicates differences in densities and locations of lithic artifact samples along the basin. Low artifact diversity, generally made on locally available raw materials is observed in surface contexts. The general spatial pattern and technological attributes suggest that the study area was occupied by hunter-gatherer groups through a logistic system of exploitation, probably while moving from nearby areas. While much additional work is required on current archaeological information of the Guillermo River taphonomic traits, lithic technology, and tool use, this analysis offers an important first step for examining prehistoric land use patterns.

Keywords: surface lithic material, geospatial analysis, hunter-gatherers, forest land use patterns, southern Patagonia.

INTRODUCTION

Southern mainland Patagonia, located at the southernmost extreme of South America (Chile and Argentina), was peopled by mobile hunter-gatherers at least ca. 12.000 years ago (Borrero 1994-95; Borrero & Martin 2017). However, the human signal in the southwestern patagonian forest is later, by at least ca. 3.000 BP (Franco et al. 1999; Mancini et al. 2011). Furthermore, explorers who travelled along the Patagonia region during the 19th and early 20th century mentioned the limited use of the southwestern forest by local groups, ethnographically known as Aónikenk or Tehuelches meridionales (Childs 1997 [1936]; Moyano 1931; Coan 2007 [1886]). They observed mobility and settlement patterns of historical hunter-gatherers and the exploitation of the forest when resources were scarce among the natives (Arms y Coan 1939 [1833]).

A first archaeological survey of the area recorded scattered findings in the transition zone between forest and steppe, but no artifact were registered in the forest (Gómez Otero 1991). Summing up surveying work in the forest area,

later studies redefined an archaeological scenario of sporadic but repeated occupations by hunter-gatherers (Borrero et al. 2008; Pallo & Charlin 2010; Charlin et al. 2011; Pallo & Borrero 2015; Carballo Marina et al. 2016; L'Heureux & Borrazzo 2016). Among the latter, an initial description of a GIS dataset of surface lithic material along the Argentinian stretch of the Guillermo River basin is added.

This paper focuses on exploring spatial patterns of surface lithic material as a basis for assessing prehistoric human land-use patterns in the study area. To attain this goal, the analysis incorporated data on three main topics: the location of surface lithic material by documenting the precise x, y, and z coordinates for each archaeological context, a general classification of these contexts based on the frequency of lithic artifacts (Borrero et al. 1992), and the general artifact classes and raw material types from which stone tools in such contexts were made. The rest of this paper briefly summarizes the archaeological background of the Guillermo River basin, the methodology used to address these topics, the

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results of the analysis, and some of the implications of these first results.


THE GUILLERMO RIVER BASIN ARCHAEOLOGY

The Guillermo River basin is located in a relatively low-elevation landscape of the Sub-Andean region of southern Patagonia (Figure 1, Oliva et al. 2001). As an intermediate point between Última Esperanza (Chile) and the eastern steppe (Argentina), the archaeology of the river basin fits perfectly into the discussion on prehistoric land-use patterns between areas facing the Pacific and Atlantic Oceans (Borrero et al. 2006). Moreover, human activity over the last 140 years, referred to indigenous people or European settlers, is also ethnographically informed (Martinic 1992, 2000) or even a little earlier, if the introduction of the horse is considered (Pallo & Borrero 2015).

Current archaeological information for the Guillermo River basin mainly comes from the Chilean territory (Emperaire 1988; San Román & Morello 2003; Langlais & Morello 2009; Legoupil 2009). Abundant archaeological record has been identified in this stretch of the basin (Última Esperanza District), especially in large eroded areas or exposed on river margins (Laming 1957; Emperaire 1988; San Román &

Morello 2003). Here, a site discovered in a rock shelter, named Cerro Castillo 1, records blade technology and a primary source lithic raw material (lutite) used for blade manufacturing (Langlais and Morello 2009).

Human occupation at the site ranges from 6200 BP up to 1900 BP (San Román & Morello 2003; Langlais & Morello 2009; Legoupil 2009), although Última Esperanza have been occupied since the Late Pleistocene (e.g. Prieto 1991) until Holocene times (e.g. Nami 1989-1990; Legoupil 2009; Morano Büchner et al. 2009; Sierpe et al. 2009).

In contrast, archaeological findings within the Argentinian stretch of the Guillermo River basin (Province of Santa Cruz) are scarce and spatially discontinuous, mainly distributed in erosion deposits on plains or terraces surrounding the river valley, and also near current forest edges (Pallo & Borrero 2015). Only two dates for the area (848 ± 45 and 998 ± 45 years BP) come from *Lama guanicoe* remains with anthropic fractures recovered from a test pit excavated at Cancha Carrera 1 (L'Heureux & Borrazzo 2016). This open air site is located at 320 meters above the Guillermo River valley in degraded forest lands. 

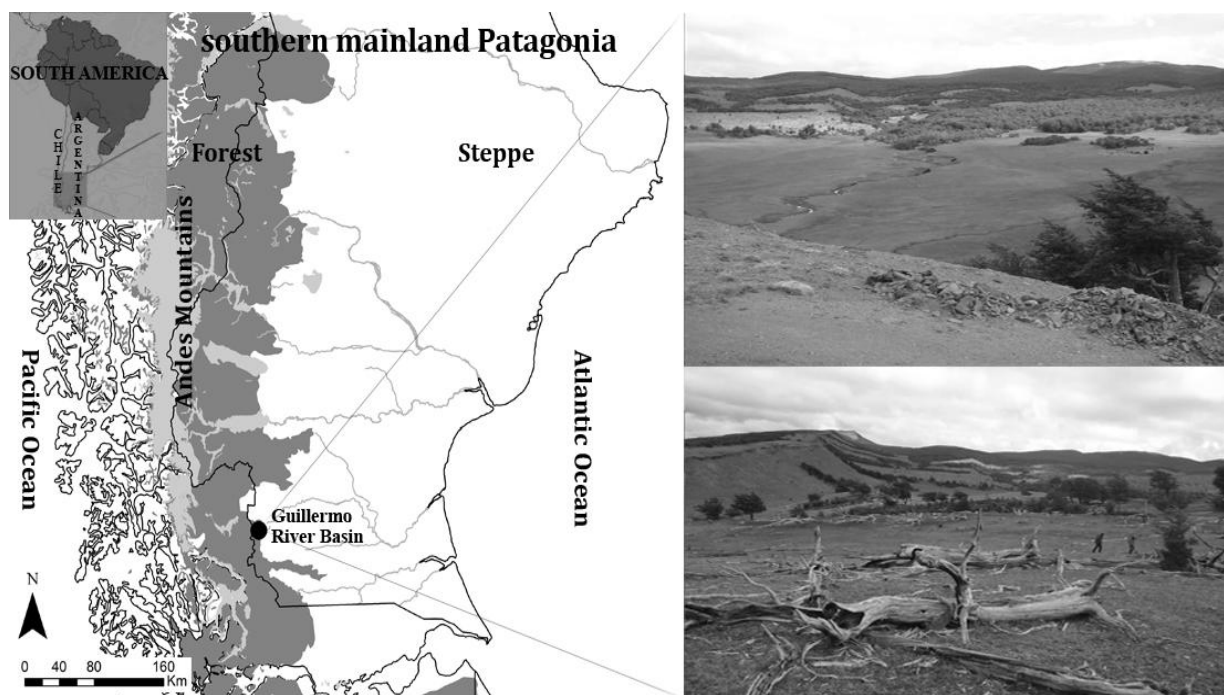


Figure1. Location of the Guillermo River basin in southern mainland Patagonia (Argentina), a view of the forests from lower to upper part of the valley (above), and the small native forest relicts or degraded forest within the basin (below).

~~This latter dispersed regional distribution, combined with the much lower frequency of~~

~~archaeological findings of the Argentinian area as compared to the Chilean area, suggests~~

different land-use patterns for the two stretches of the Guillermo River basin. Despite that, similar technological attributes were exhibited by them, such as the presence of lutite as the main lithic raw material used in tool manufacture, non-local obsidian artifacts (the Pampa del Asador black obsidian, the Baguales grey-green obsidian, and the Otway green obsidian) and cervid (*Lama guanicoe*) as the principal terrestrial resource exploited (Emperaire 1988; Ortiz Troncoso 1972; San Román & Morello 2003; Langlais & Morello 2009; L'Heurex & Borrazzo 2016). These latter aspects, in turn, reveal the common background in technology and subsistence of local hunter-gatherers as well as contact with areas located further north and south. Thus, the Guillermo River valley may be seen as a potential dispersal pathway of humans, goods and information in the forest landscape of southern Patagonia during past times (Pallo & Borrero 2015).

THE GIS DATASET OF SURFACE LITHIC MATERIAL

Paleoenvironmental information and local livestock activity suggest that most of the archaeological record in the Argentinian stretch of the Guillermo River basin, sets within the current transition zone between forest and steppe, should have been part of the forest until recently (Peri & Ormaechea 2013). Although anthropogenic activity accelerates soil erosion, forest degradation and stratified sites destruction, it also has profound implications for the archaeological visibility (Borrero & Muñoz 1999). This latter emphasizes the current optimal conditions of visibility for addressing surface scatters. In spite of this, as is the case for many archaeological contexts in mainland southern Patagonia, those investigated for the study area contain relatively sparse amounts of faunal material as well as a fairly limited array of other cultural debris on surface. Lithic scatters therefore comprise the majority of the material which can be used to address land-use patterns of prehistoric hunter-gatherers.

Surface lithic material presented here was collected during fieldwork carried out in 2012, 2013, 2014 and 2015 (Figure 2). Archaeological prospecting was conducted using a criteria based on geolocation with GPS, combined with geomorphological and environmental features, and the most prominent taphonomic processes

and their effects on the conservation and visibility of the archaeological record. These later aspects and the main techno-morphological characteristics (sensu Aschero 1975, 1983) and lithic raw material types (determined primarily by macroscopic comparison with samples of petrographic thin sections) of surface lithic scatters are still being processed, so that they are briefly presented here.

Three categories were used as surface collection units (Borrero et al. 1992):

- isolated finding: lithic artifact surrounded by a circle that is 20 meters in diameter with no other findings.
- cluster: lithic assemblage of 2 to 24 artifacts within a circle that is 20 meters in diameter.
- site: lithic assemblage of 24 or more artifacts within a circle that is 20 meters in diameter, or a larger area.

This information was then turned into a GIS spatial database, where single locations were given to each surface collection unit registered in the field. Such spatial geometries thus now represent discrete points and are therefore analytically comparable for exploring land-use patterns. To do so, Kernel density estimation (KDE) that is a non-parametric tool for documenting spatial point patterns, was used. This geostatistical tool quantifies the spatial structure of data points by creating a contingency table or grid with their coordinates, in which the observed value of each cell is compared with an expected numerical value in that cell, according to the number of points contained in each of the neighboring cells (Baxter & Beardah 1995; Hawkins et al. 2003). This provides a smooth surface of point density estimates in a given area that shows data deviation from a null hypothesis of spatial homogeneity (Poisson distribution).

KDE works by placing a curved surface over each point (known as kernel function) with a user-defined search radius (known as bandwidth) resulting in a map of probability density that smoothly decreases with distance from each point. The outcome is a smoothly curved surface, in which similar values of density in different locations are connected through isolines or colour scales, giving a quick and complete view of the point pattern. For any

location within the study area, the kernel density  estimate is given by:



Figure2. Surface lithic material in the Argentinian stretch of the Guillermo River basin: lithic clusters (above), Cancha Carrera 1 site (left below, photo by LHeureux & Borrazzo 2016:113) and an isolated finding manufactured on lutite (right below).

$$\lambda(u) = \sum_{i=1}^n \kappa(u - x_i)$$

Where λ is the density of the feature class at location u and κ is an isotropic Gaussian kernel with smoothing bandwidth computed using the fourth-grade kernel function that was described in Silverman (1986), which is robust to spatial outliers. KDE analysis was run in ArcGIS 10.1 (ESRI) and computed for isolated artifacts, clusters and archaeological sites that are visualized as expected counts per km^2 .

RESULTS

Surface lithic material in the Argentinian stretch of the Guillermo River basin (Figure 3, panel A) shows a higher frequency of isolated findings (48) and lithic clusters (35), and very few archaeological sites (7). It also reveals important differences between the distributions of these categories. Isolated findings are those that are most dispersed within the basin. In contrast, lithic clusters and sites tend towards concentration, the first over the northwest

portion of the basin (with the exception of a lithic cluster located in the southwest part of the basin) and the latter in the central portion of the basin (with the exception of a site located in the northwest part of the basin). In fact, those sites located in the central portion of the basin coincide spatially with the southern end of the distribution of lithic clusters.

The KDE demonstrates that isolated artifacts (Figure 3, panel B) are often in association with the northwestern forest of the basin and especially along the base of the hills and terraces surrounding the Guillermo River valley. In particular, the northwestern forest and eastern hills have similar values of density (0.07 to 15). Other isolated findings are present within the southwest forest of the basin, primarily associated with depressed areas of the landscape and relatively low densities (0 to 5). A latter group of isolated findings in different sectors of the valley floor raises the possibility that these artifacts are in secondary contexts, having been transported by dropping of sediments from high sectors of the landscape to their current locations (Pallo & Borrero 2015). This could

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also explain the highest density of isolated findings for the middle valley floor of the Guillermo River basin (0 to 20).

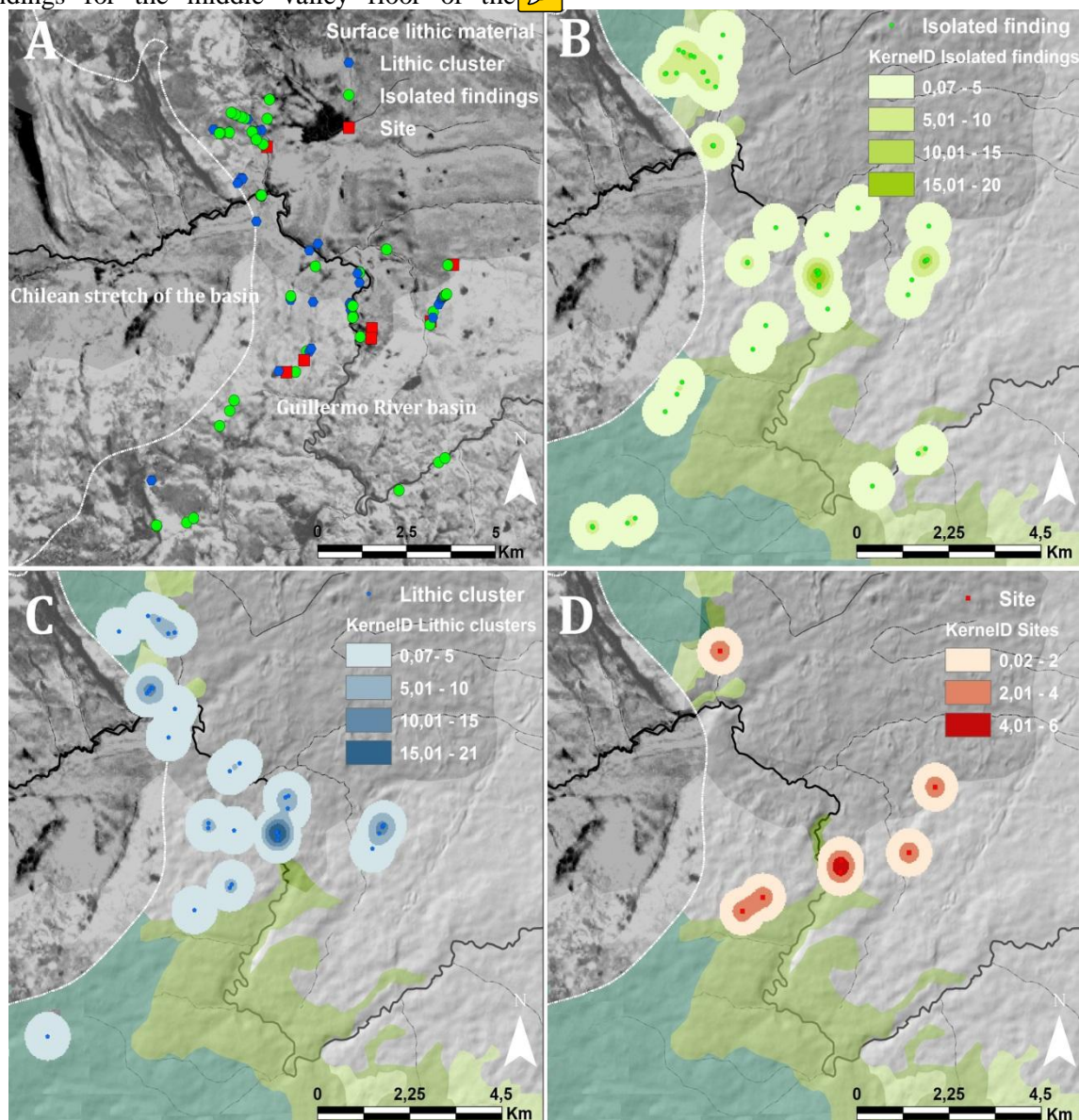



Figure 3. Surface lithic material (A) and KDE plots that depict expected frequencies per km² for isolated artifacts (B), lithic clusters (C), and archaeological sites (D).

Lithic clusters are also well represented in the northwestern forest of the basin, and primarily on the hills and terraces surrounding the valley, but generally at higher elevations than the isolated findings (Figure 3, panel C). High concentrations of lithic clusters are found on the base of eastern hills and in the northwestern transition zone between forest and steppe (0 to 15), and to a lesser extent within the northwestern forest (0 to 5). Other lithic clusters are located in portions of the valley floor. Indeed, the most important density of lithic clusters (0 to 21) is in association with the highest density of isolated findings within the middle valley floor (0 to 21). This, in turn, could

also imply a possible taphonomic trait of the lithic clusters in the middle valley floor, such as was mentioned above for the nearby isolated findings.

There are few archaeological sites located at high elevations on hill tops, primarily associated with the middle Guillermo River basin (Figure 4, panel D). All of them are located in the steppe, although some ones are also close to the current forest edges (Pallo and Borrero 2015). The concentration of archaeological sites in the middle Guillermo River basin suggests a repeated use of high places and exposed to the wind erosion, whose use is likely to have been influenced by the benefits of occupying

relatively flat land with view and nearby valley access. Moreover, the highest density of sites (0 to 6) is located less than 1 km from the highest  A first description of the surface lithic material indicates that 1795 artifacts are involved, dominated by debitage, and to a lesser extent cores and tools. They were made almost exclusively on locally available raw material, primarily sedimentary rocks (e.g. Lutite, a fine-grained sedimentary rock), and to a lesser extent silicates and volcanic rocks. Different types of non-local obsidian are rarely found in samples.

FINAL REMARKS

Surface lithic material presented here begins to glimpse advances in the information available for the southern western forest in mainland Patagonia. These findings are still few, but they already point out that the previous western boundary established for the distribution of hunter-gatherers (Gómez Otero 1991) needs to be revised (Borrero et al.2008; Charlin et al. 2011).

While the KDE shows a low-intensity occupation in the Guillermo River basin, lithic technology (including diversity and density) primarily indicates specific activities, although with repeated, planned use of at least some locations in the middle basin, which record lithic tools as part of on-site equipment used in resource processing (L'Heureux & Borrazzo 2016). KDE also demonstrates that the total density of artifacts decreases towards the southern portion of the basin, which in turn suggests a greater connection with the Chilean stretch of the basin. The sporadic use of the Argentinian stretch from western lands could have occurred, probably based on the existence of a low cost pathway to transmontane areas (Pallo & Borrero 2015). The abundant archaeological record in the Chilean area, combined with a low density of archaeological findings in other areas to the east (Carballo Marina & Madryn 2012) and south (Carballo Marina et al. 2016) of the Argentinian stretch of the basin, also fits in with the idea.

However, some technological attributes exhibited by surface and excavated lutite artifact samples emphasize a possible common technological background of local hunter-gatherers with other groups from the steppe (Borrazzo 2008, L'Heureux & Borrazzo 2016). Different types of non-local obsidian (the Pampa del Asador black obsidian and the Baguales gray-green obsidian) from sources

~~density of both the isolated findings and the lithic clusters.~~

located in areas further north of the Guillermo River basin, also supports these connections. In addition, a projectile point manufactured on Otway-Riesco green obsidian, a rock used by canoe groups located on the western border of Patagonian-Fuegian islands, also indicates contact with maritime hunter-gatherers.

In sum, this information posits key aspects that need to be addressed, but it also illustrates potential uses of the archaeological GIS dataset to understand broader aspects of hunter-gatherers in the Argentinian stretch of the Guillermo River basin. Whether these lands were part of a logistic system of exploitation within home-ranges of hunter-gatherers inhabiting western lands or the steppe (northern and / or eastern lands), or both, still needs a revision. Whether the general spatial pattern, and especially the highest density of lithic artifacts in the middle Guillermo River basin, is associated with possible taphonomic biases (e.g. dropping of sediments from high sectors of the landscape to the middle Guillermo River valley or decreased archaeological visibility due to more dense forest in southern than central and northern parts of the basin) also remains to solve. The goal of future analysis therefore is to complete this initial description of surface lithic material and refine the spatial and technological patterns observed.

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